TIPS & LESSONS LEARNED: FOR SONDE/SENSOR DEPLOYMENT IN WADEABLE STREAMS DOMINATED BY COBBLES AND BOULDERS.

- THE SENSOR DEPLOYMENT LOCATION SHOULD PROVIDE ENOUGH DEPTH TO COMPLETELY COVER THE SENSOR (KEEPING POTENTIAL CHANGES IN DEPTH IN MIND), ADEQUATE FLOW TO KEEP THE SENSOR FREE OF SEDIMENT AND DEBRIS, A LOCATION FOR THE SENSOR TO BLEND INTO THE SURROUNDING SUBSTRATE OR BE CAMOUFLAGED INTO IT, AND A STRONG/PROPERLY POSITIONED (WITH RESPECT TO DEPTH, FLOW, AND CONCEALMENT) ANCHOR POINT FOR SAFETY BACK-UP CABLE. FAILURE TO MEET THESE REQUIREMENTS SUBJECTS THE DATA COLLECTED TO PREVENTABLE ERROR AND THE EQUIPMENT TO POTENTIAL THEFT OR LOSS.

DEPLOYMENT EQUIPMENT & POTENTIAL PURCHASING LINKS

- PERFORATED PROTECTIVE DEPLOYABLE SENSOR PVC CASE AND CAP (TYPICAL SEWER SYSTEM GRADE PVC)
- CABLE/BOLT CUTTERS OR GOOD QUALITY WIRE CUTTERS. HTTP://WWW.LOWES.COM/PD_464602-16878-55764___?PRODUCTID=50069703&PL=1&NTT=BOLT+CUTTERS OR HTTP://WWW.LOWES.COM/PD_39714-922-338_1Z11PBI__?PRODUCTID=1085489&PL=1
  - CUTTERS SHOULD BE TESTED OCCASIONALLY TO ENSURE A CLEAN CUT OF WIRE AS FRAYS MAKE USE WITH FERRULES DIFFICULT.
  - WIRE CUTTERS AS COMPARED TO BOLT CUTTERS WILL REQUIRE SOME HAND STRENGTH TO CLOSE AND PROVIDE CLEAN CUT; HOWEVER SOME WIRE CUTTERS ARE NOW BEING DESIGNED FOR OPTIMAL LEVERAGE MAKING THIS MUCH EASIER.

- SWAGING TOOL/CRIMPING TOOL HTTP://WWW.LOWES.COM/PD_348539-258-ST18BK___?PRODUCTID=3462290&PL=1&NTT=SWAGGING+TOOL

- 1/8" GALVANIZED CABLE HTTP://WWW.HARDWAREANDTOOLS.COM/APEX-TOOL-GROUP-7000427-CAMPBELL-1-8-INCH-500-FOOT-REEL-UNCOATED-CABLE-EGLA-4237.HTML
  - I RECOMMEND TO ALWAYS BRING EXTRA CABLE TO SITE.

- 1/8" FERRULES HTTP://WWW.HARDWAREANDTOOLS.COM/APEX-TOOL-GROUP-7670724-52337-CAMPBELL-1-8-INCH-ALUMINUM-CABLE-FERRULES-ECDA-9928.HTML
  - HARDWARE AND TOOLS WEBSITE IS THE MOST AFFORDABLE LOCATION I HAVE FOUND FOR PURCHASING CABLE AND FERRULES AS COMPARED TO AVERAGE HARDWARE STORE WHERE THE PRICE PER FOOT CAN BE **MUCH** HIGHER THAN BULK PRICE FOUND ONLINE.

- **CABLE ANCHOR LOCATIONS**
  - ROOT-WADS ARE THE PREFERRED ANCHORING PLATFORM WHEN AVAILABLE. A ROOT-WAD PROVIDES NATURAL CONCEALMENT AND MULTIPLE LOCATIONS TO ATTACH THE ANCHOR IN A MANNER THAT WILL BE VERY STABLE UNDER ALL BUT THE MOST EXTREME CONDITIONS. THE ANCHOR SHOULD BE LOOPED AROUND THE LARGEST ACCESSIBLE PIECE OF ROOT STRUCTURE THAT ALLOWS THE SENSOR CABLE TO BE CONCEALED AS WELL AS POSITIONED IN THE SUBSTRATE SO THAT IT RECEIVES PROPER FLOW, DEPTH, AND CONCEALMENT.
  - IF A ROOT-WAD IS UNAVAILABLE OR NOT CLOSE ENOUGH TO THE STREAM, THE NEXT BEST ANCHOR IS AN INSTREAM BOULDER. IN ORDER TO ANCHOR TO A BOULDER, IT HAS TO BE SHAPED SO THAT THE ANCHOR CABLE CANNOT SLIP OVER THE BOULDER AND LARGE ENOUGH THAT THE CABLE WILL NOT BE PULLED OUT FROM UNDER IT. IDEALLY THE BOULDER NEEDS TO PROVIDE PROTECTION FROM DEBRIS AND HIGH FLOWS WHILE NOT SUBJECTING THE SENSOR TO UNACCEPTABLE SEDIMENT ACCUMULATION WHICH WOULD FILL THE SENSOR CASE AND INHIBIT DATA COLLECTION. THE CABLE SHOULD BE LOOPED AROUND THE BASE OF THE BOULDER AT A PINCH POINT, WHERE THE CABLE CANNOT SLIP OVER THE OVER THE TOP OF THE ROCK. EVERY ATTEMPT SHOULD BE MADE TO ENSURE THAT BOULDER IS STABLE AND WILL NOT MOVE OR SHIFT.
- **CABLE ANCHOR MAINTENANCE**
  - WELL-PLACED AND MAINTAINED ANCHORS ARE THE PRIMARY DEFENSE AGAINST EQUIPMENT LOSS. THE BEST ANCHOR POINT IS USELESS IF THE ANCHOR ITSELF IS NOT CHECKED AND REPLACED PERIODICALLY. YEARLY REPLACEMENTS ARE REQUIRED. BEYOND THAT, ANCHORS SHOULD BE CHECKED AT EACH DEPLOYMENT FOR EXCESSIVE CORROSION, KINKS, BREAKAGE, OR OTHER SIGNS OF WEAKNESS AND REPLACED IMMEDIATELY IF ANY INDICATIONS OF FAILURE EXIST. ANCHORS SHOULD BE LOCATED AND ACCESSIBLE IN A VARIETY OF FLOW REGIMES TO ALLOW CHECKS; AND NOT JUST DURING LOW FLOW EVENTS.
- **CONCEALMENT**
  - CONCEALING THE SENSOR SERVES SEVERAL PURPOSES. IT PROTECTS THE SENSOR FROM BEING SPOTTED BY INDIVIDUALS WHO MIGHT DISTURB OR ATTEMPT TO STEAL/SABOTAGE THE EQUIPMENT. ADDITIONALLY, IF DONE CORRECTLY, IT PROVIDES STABILITY AND PROTECTION FROM INCREASES IN FLOW THAT MIGHT BATTER, DISLODGE, OR MOVE THE SENSOR. THE BEST MATERIAL FOR CAMOUFLAGE, WHEN AVAILABLE, IS IN-STREAM LARGE COBBLE AND BOULDER-SIZED SUBSTRATE. THE MAIN METHOD FOR ESTABLISHING EFFECTIVE CONCEALMENT FOR THE DEPLOYABLE IS TO SURROUND THE SENSOR ON ALL SIDES WITH LARGE SUBSTRATE IN A MANNER THAT THE PROBES ARE PROTRUDING FROM THE END OF THE SUBSTRATE IN A COLUMN OF MODERATE TO SWIFTLY MOVING WATER. CARE MUST BE TAKEN TO PLACE THE PROBE END OF THE SENSOR IN A MANNER THAT WILL KEEP IT OFF THE BOTTOM AND INTO A FLOW VECTOR THAT WILL MINIMIZE SEDIMENT ACCUMULATION WITHIN THE SENSOR CASE. IN LOCATIONS THAT DO NOT PROVIDE ADEQUATE SUBSTRATE FOR THE CONSTRUCTION OF THIS TYPE OF STRUCTURE, CREATIVITY WILL BE NECESSARY. TIRES, CINDER BLOCKS, VEGETATION, WOODY DEBRIS, AND PIECES OF TRASH WILL ALSO SERVE NICELY TO PROVIDE THE NECESSARY MATERIALS FOR CONCEALMENT. IN SOME CASES THE ANCHOR POINT ITSELF CAN PROVIDE ADEQUATE CONCEALMENT, SUCH AS WHEN DENSE ROOT-WADS ARE PRESENT. STREAM STRUCTURE CAN ALSO BE USED TO CREATE EFFECTIVE CONCEALMENT, TRY USING UNDERCUTS, BEDROCK FRACTURES, OR OTHER NATURAL FEATURES WHEN OTHER METHODS ARE INADEQUATE OR UNAVAILABLE. CONCEALMENT OF BOTH THE SENSOR CASE, AND ANCHOR CABLE IS RECOMMENDED TO PREVENT ANY TAMPERING.

EAST FORK OF GREENBRIER RIVER


Cable anchored to tree root. Runs along groove between 2 boulders. Hidden/obscured with rocks/moss/debris.
Level logger mounted with epoxy to flat boulder face.
Boulder serves as stable mounting structure & protects from high flow debris impacts.
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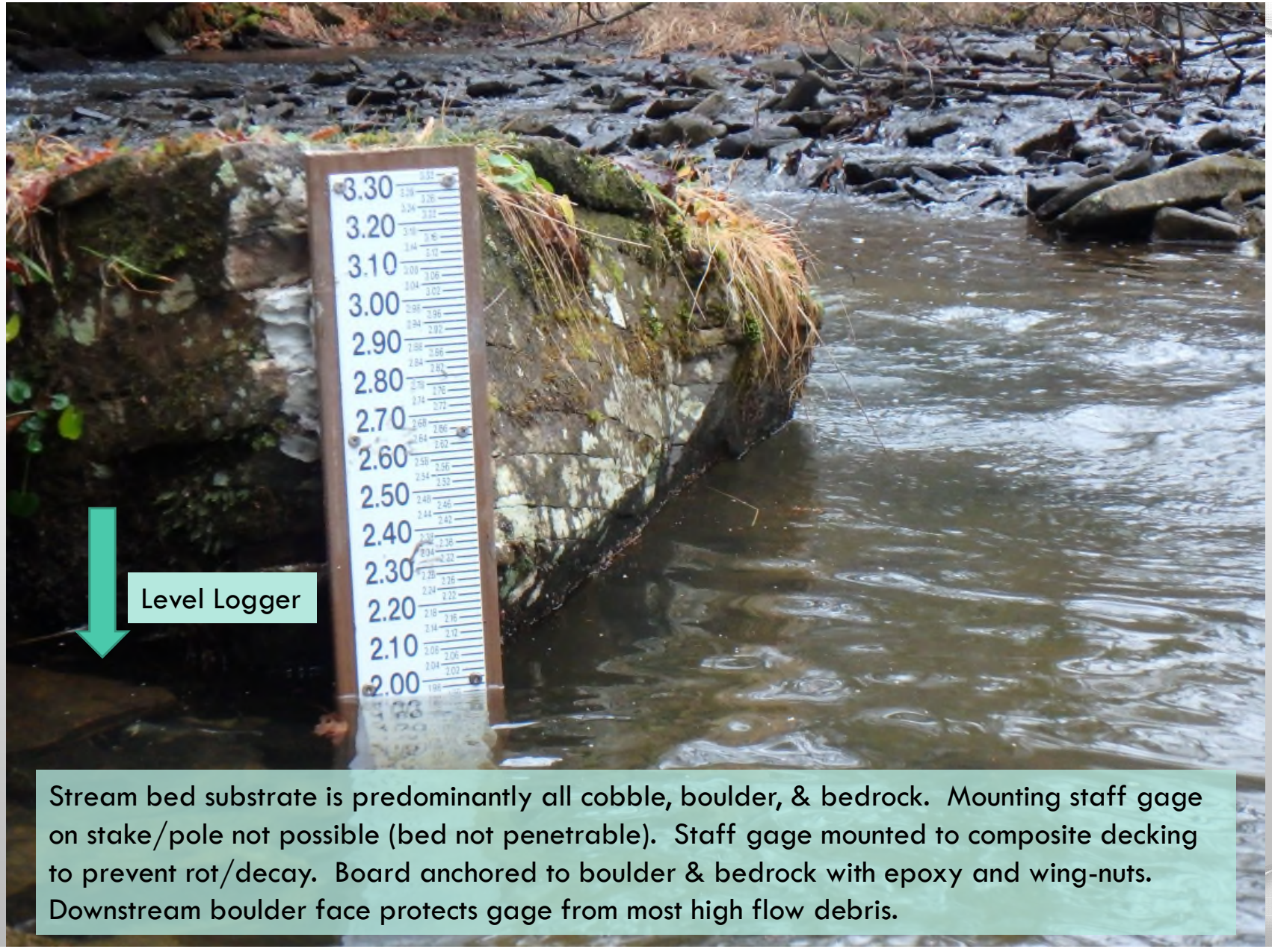
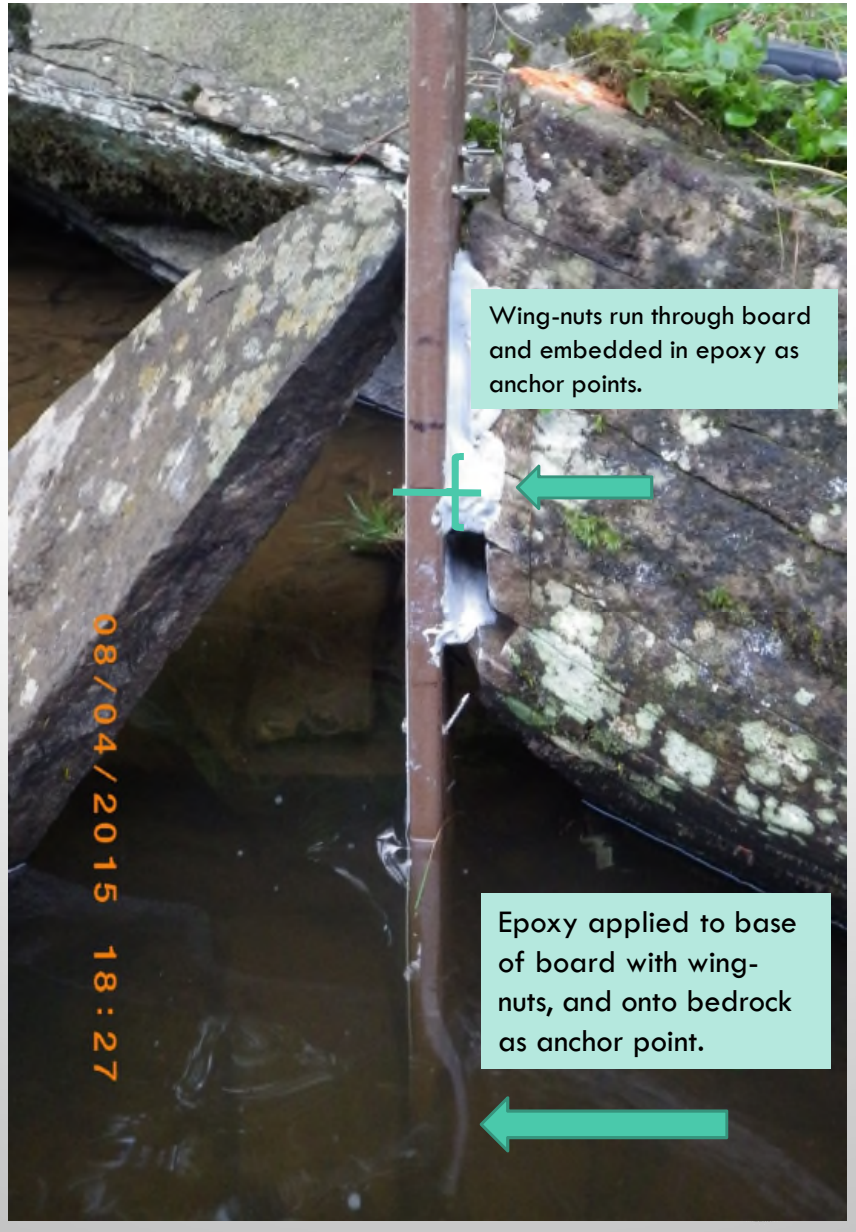


Stream bed substrate is predominantly all cobble, boulder, & bedrock. Mounting staff gage on stake/pole not possible (bed not penetrable). Staff gage mounted to composite decking to prevent rot/decay. Board anchored to boulder & bedrock with epoxy and wing-nuts. Downstream boulder face protects gage from most high flow debris.


Wing-nuts run through board and embedded in epoxy as anchor points.
Epoxy applied to base of board with wing-nuts, and onto bedrock as anchor point.
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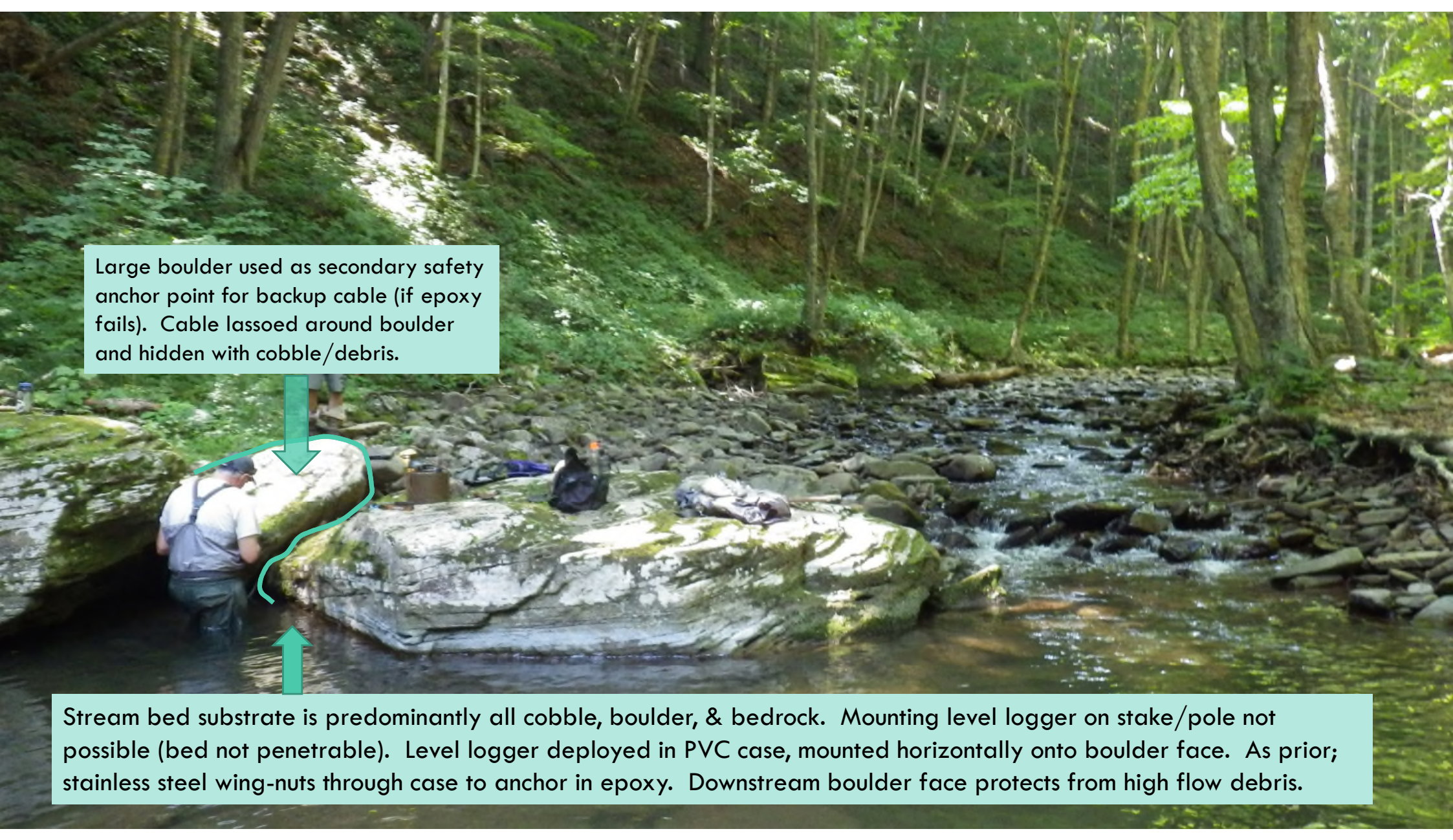
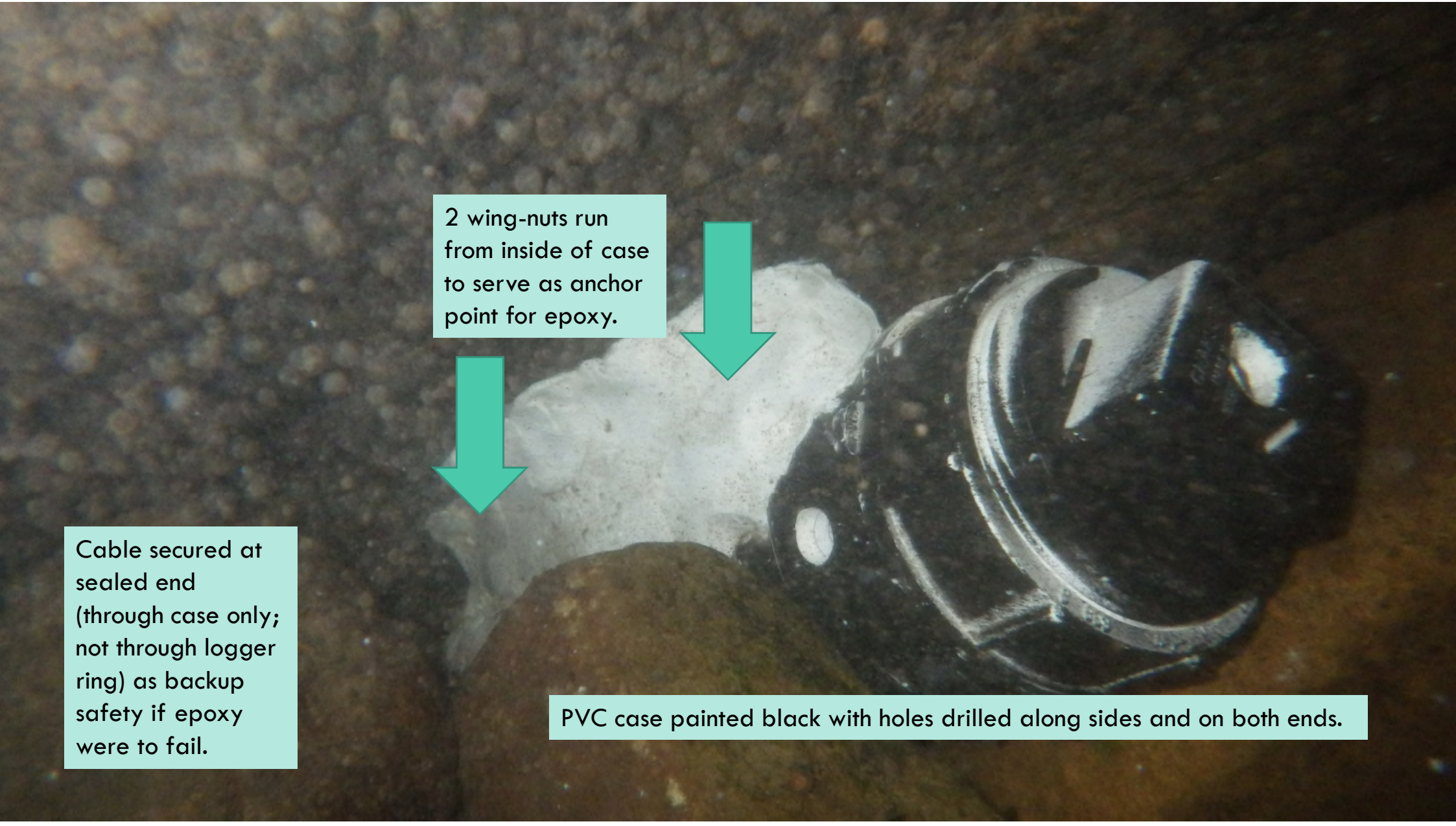
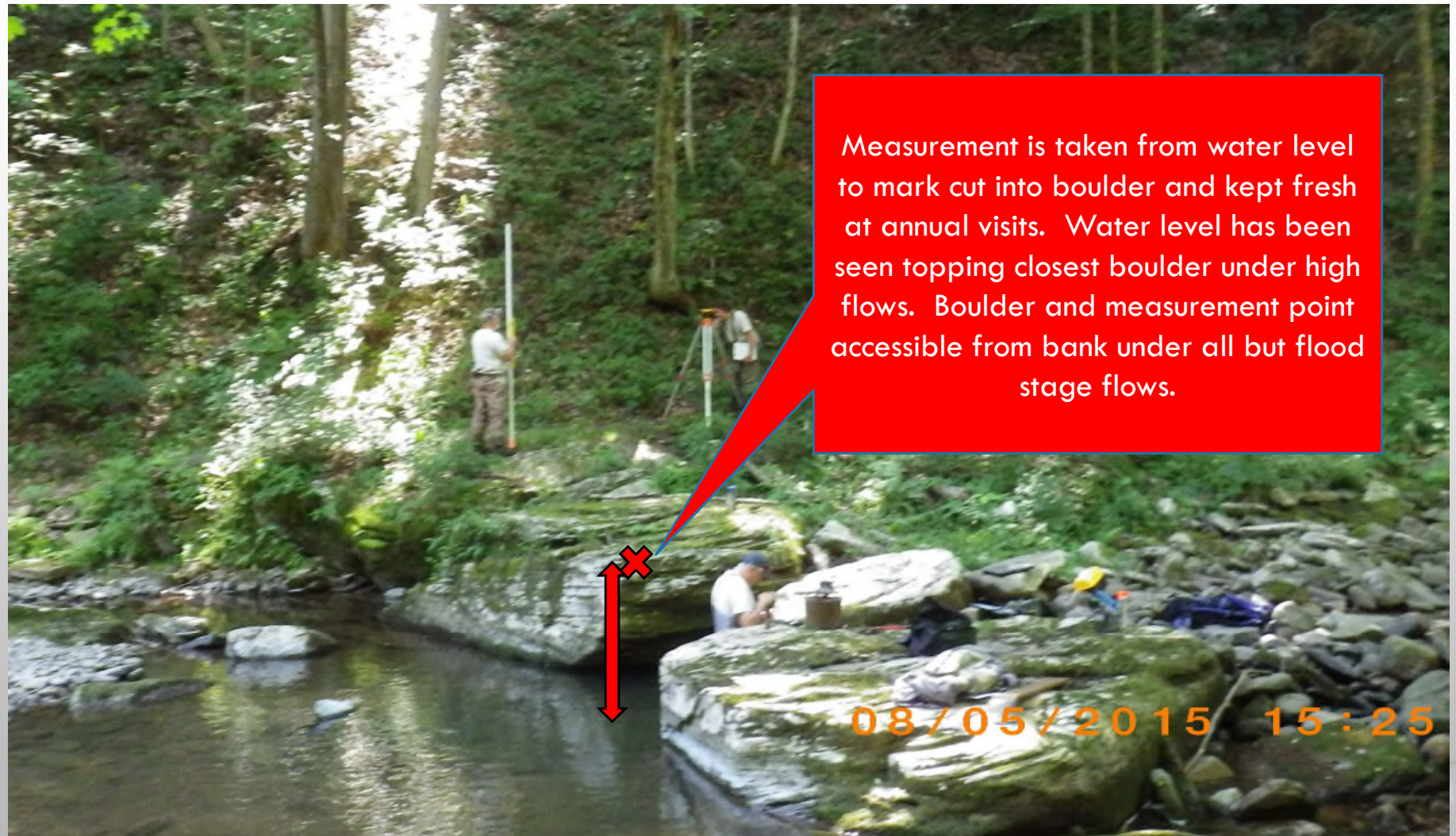
BIG RUN OF SOUTH BRANCH POTOMAC


Large boulder used as secondary safety anchor point for backup cable (if epoxy fails). Cable lassoed around boulder and hidden with cobble/debris.
Stream bed substrate is predominantly all cobble, boulder, & bedrock. Mounting level logger on stake/pole not possible (bed not penetrable). Level logger deployed in PVC case, mounted horizontally onto boulder face. As prior; stainless steel wing-nuts through case to anchor in epoxy. Downstream boulder face protects from high flow debris.


2 wing-nuts run from inside of case to serve as anchor point for epoxy.
Cable secured at sealed end (through case only; not through logger ring) as backup safety if epoxy were to fail.
PVC case painted black with holes drilled along sides and on both ends.

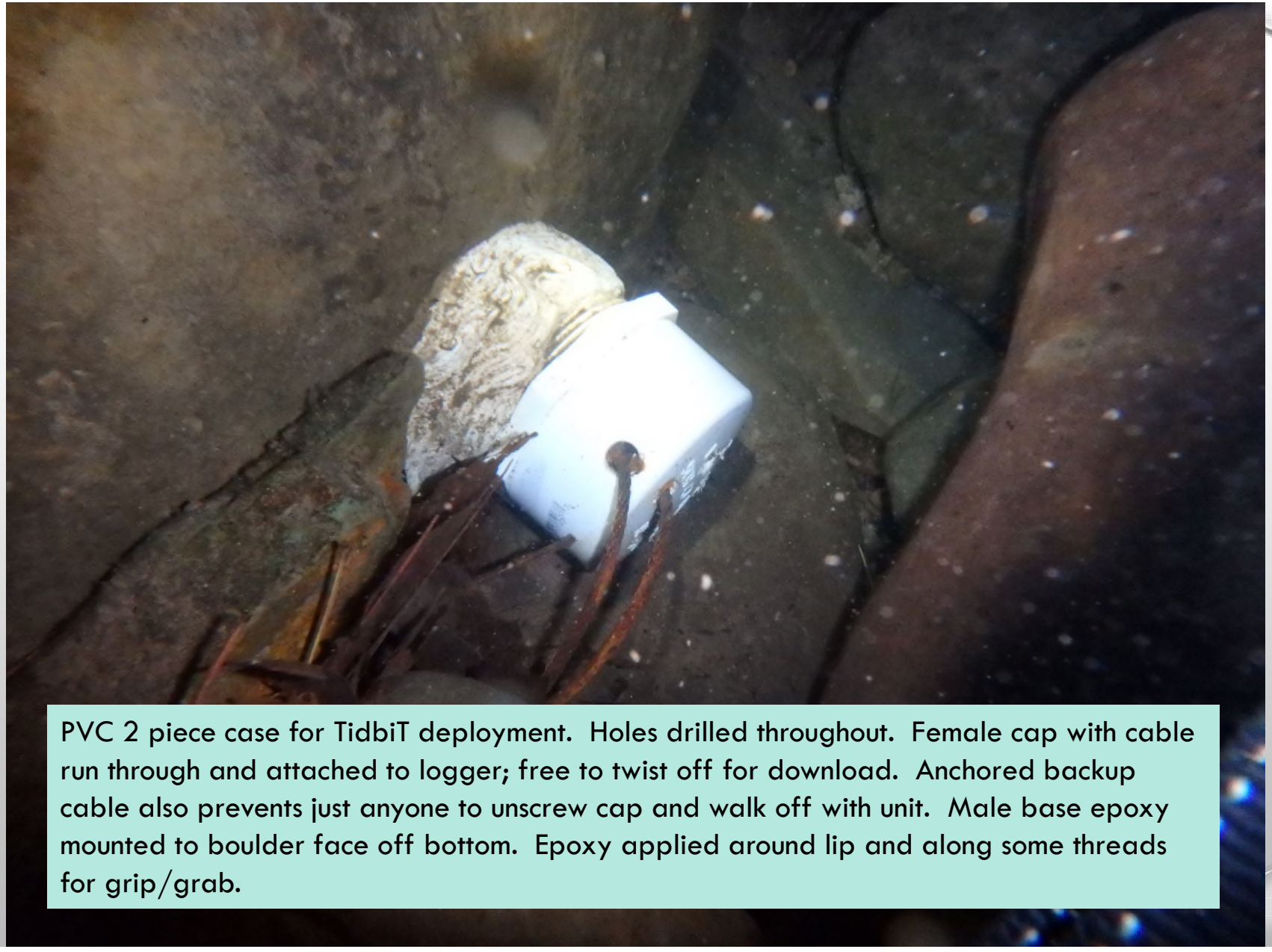
Post deployment view down along flat face from top of boulder. Leaf deposits but no sign of sediment deposition.

RECORDING STREAM HEIGHT WITH NO STAFF GAGE



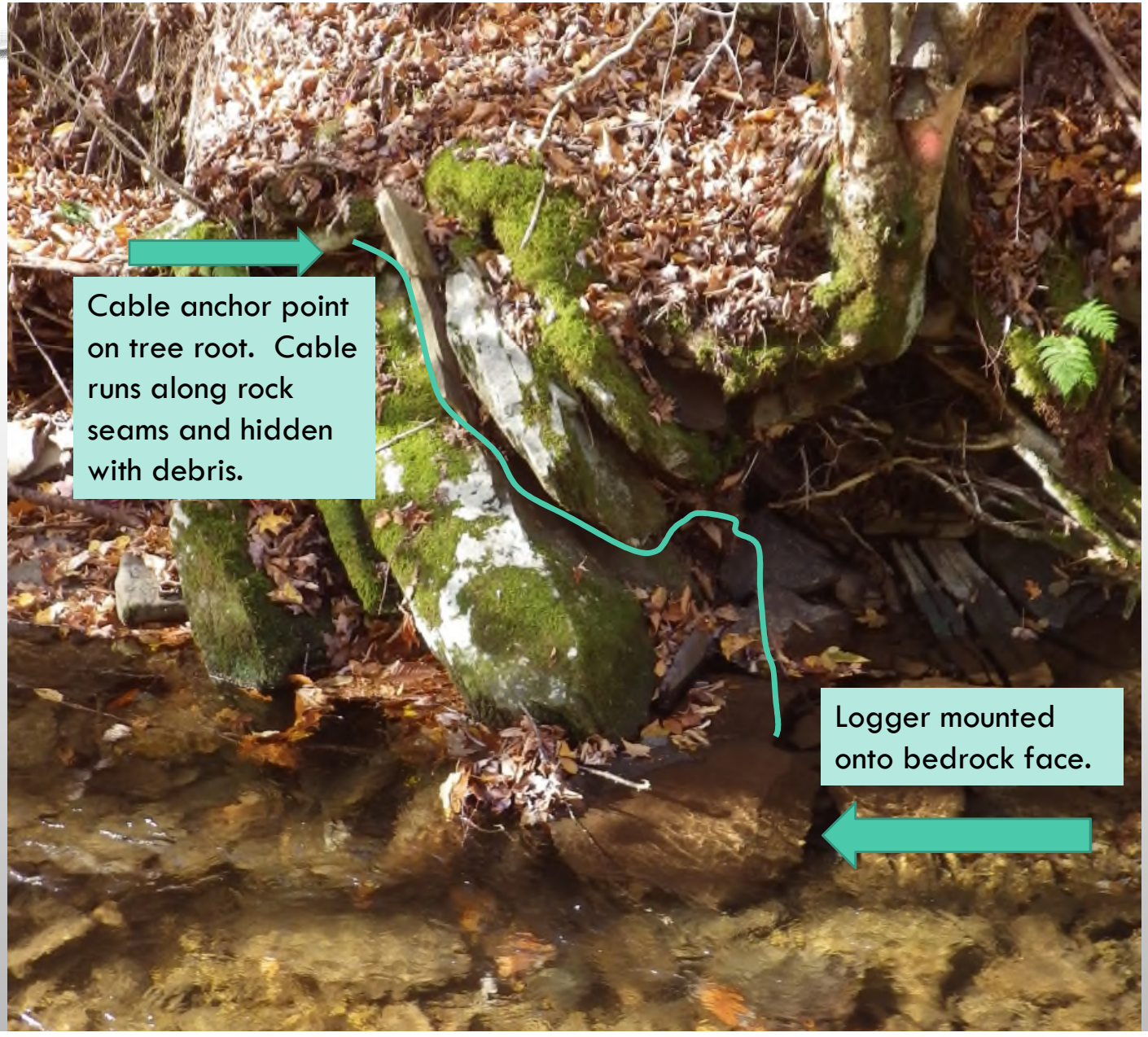
SENECA CREEK

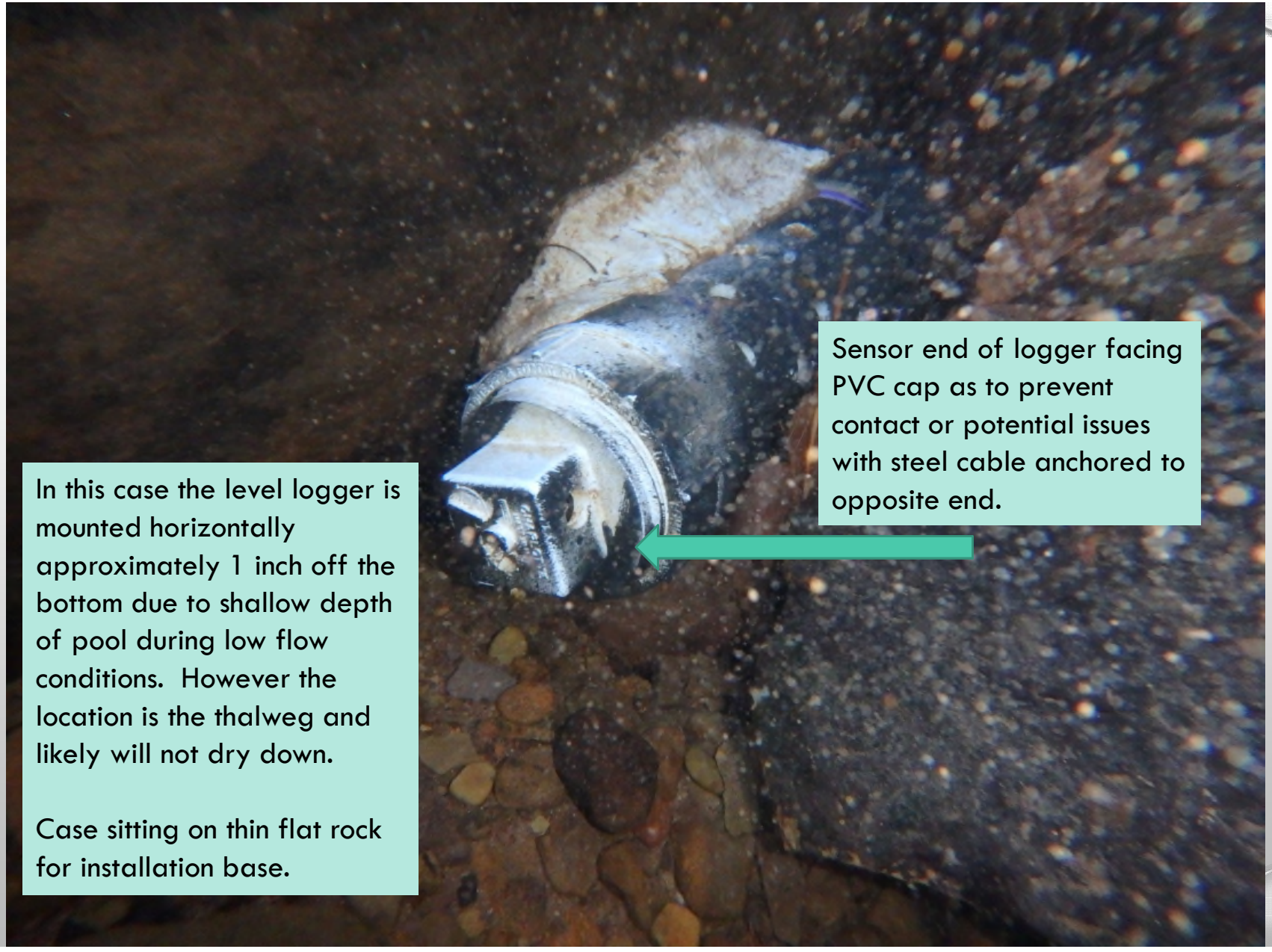

Right bank boulder embedded into bank and down into creek-bed used to mount temperature logger. Large tree roots just above used as anchor point for backup cable.
Shallow Riffle
Deep Protected Pool/Run



PVC 2 piece case for TidbiT deployment. Holes drilled throughout. Female cap with cable run through and attached to logger; free to twist off for download. Anchored backup cable also prevents just anyone to unscrew cap and walk off with unit. Male base epoxy mounted to boulder face off bottom. Epoxy applied around lip and along some threads for grip/grab.

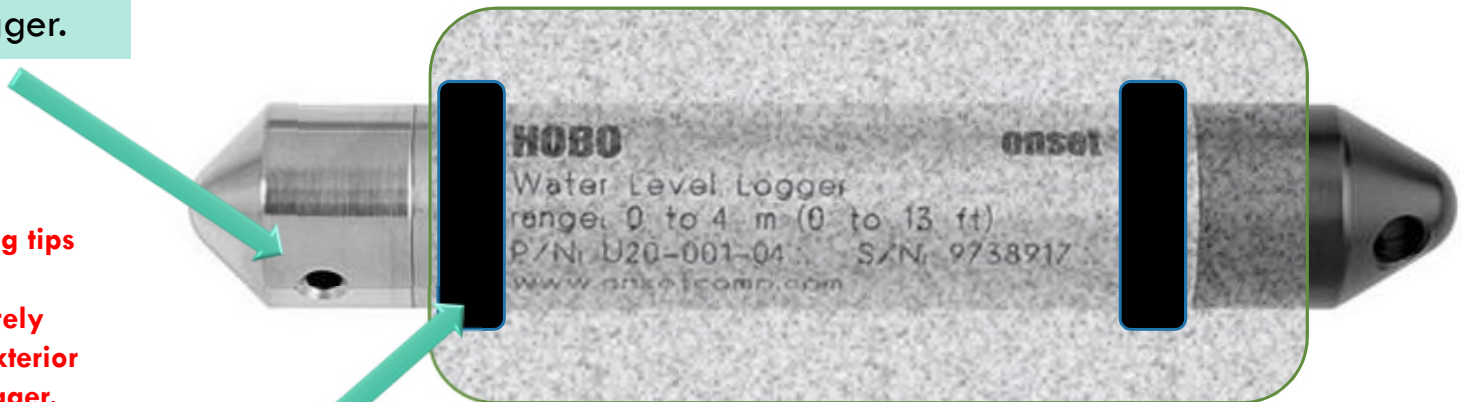
BIG RUN OF GANDY CREEK


Cable anchor point on tree root. Cable runs along rock seams and hidden with debris.
Logger mounted onto bedrock face.


Sensor end of logger facing PVC cap as to prevent contact or potential issues with steel cable anchored to opposite end.
In this case the level logger is mounted horizontally approximately 1 inch off the bottom due to shallow depth of pool during low flow conditions. However the location is the thalweg and likely will not dry down.
Case sitting on thin flat rock for installation base.

Neither rubber rings or pipe insulation is installed near or surrounding the sensor opening of the level logger.

Foam pipe insulation used as stabilization sleeve for level logger. Rubber rings protect logger; but also provide non-slick grip onto pipe insulation. Pipe insulation should snuggly fit the inside diameter of the PVC chosen to prevent logger movement. The heads of wing-nuts as well as rough texture from holes drilled into PVC should also provide grip to prevent insulation from slipping/moving.



Rubber chair leg tips whose inner diameter is barely smaller than exterior diameter of logger. (Lowes/Home Depot)

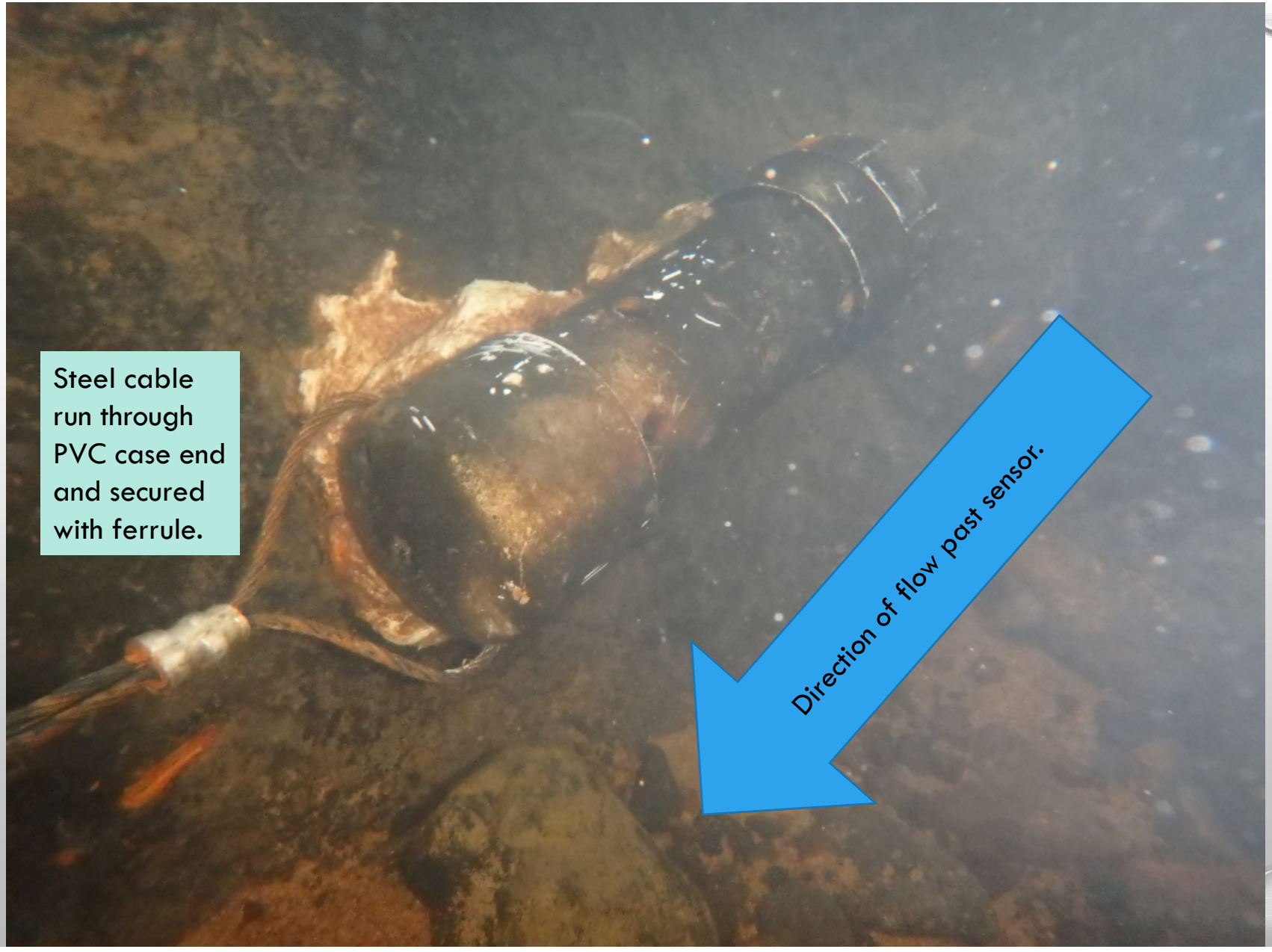
Cut in half into rubber ring with hacksaw.

NOTE: This foam sleeve will need to be removed for deployment and download so unit can be inserted into shuttle. Once unit is successfully launched from HOBOware; the unit as seen above is inserted (plastic tip readout end first) into PVC case.

SOUTH FORK OF CRANBERRY RIVER


Shallow Riffle during low water events.
Deeper run is cross sectional thalweg (Sensor Location).


Large boulder (buried into stream bed) used as secondary safety anchor point for backup cable (if epoxy fails). Cable lassoed around boulder and hidden with cobble/debris.
Logger deployed on smooth face of boulder near stream bottom. (Boulders/cobbles used to hide unit)


Steel cable run through PVC case end and secured with ferrule.
Direction of flow past sensor.

RECORDING STREAM HEIGHT WITH NO STAFF GAGE

- Stream bed not penetrable (abundant large boulder).
- Most thalwegs to record low flow water levels are mid-stream. (No appropriate mounting locations)
- Thalweg at edge where logger is deployed is at head of large erosional scar and would not protect staff gage from high flow debris.

MEASUREMENT FROM WATER LEVEL TO TOP OF BRIDGE BEAM WOULD SERVE AS SURROGATE UNDER ALL FLOW CONDITIONS.

Example: Steele cable used to secure air logger.

Air temperature logger remains deployed in solar shield after bear damage removed bottom of solar shield. Note the steel cable securing unit to tree preventing easy removal.